Measure: Expand Green Building Program / Energy Codes (G22)

Individual components of the *City of Tucson Green Building Program* are dissected to provide the Climate Change Advisory Committee the data on the efficacy of possible building code adoptions. Ultimately, the analysis covers the emission abatement potential associated with adopting the 2012 International Energy Conservation Code (IECC). It will be shown below that many of the individual components of the *Green Building Program* are analyzed via other measures in this report.

COT ARRA RFP Summary:

Emission reduction potential by 2020:	See individual Measures For 2012 IECC Adoption for Residential & Commercial: 114,235
Percentage of goal (2012):	NA (Code enforcement would commence January 1, 2013)
Percentage of goal (2020):	5.04%
Total annual average implementation costs:	$5.4 million over 10 years
Entity that bears the costs of implementation:	Developer/Homebuilder
Net savings per tCO_2e:	\$97 / tCO_2e
Net annual savings:	$8.6 million over 27 year life of program
Entity that realizes the financial return:	Ratepayer
Equitability (progressive/regressive, income/revenue neutral, etc):	Neutral
Potential unintended consequences:	None identified

Background information:

The prologue to the City of Tucson's voluntary Green Building Rating System captures the essence of needing building codes that reflect local realities.[1] The document contains an elegant statement on the impact of the built environment, deserving to be rewritten here in full: [2]

> *"Of all human activities, the decisions we make in the design and construction of the built environment have perhaps the most significant impact on our natural surroundings, our social structure, and the long term economic viability of a community."*

In this context, "green building" encompasses a much broader scope that this lone analysis will cover. However, when taken in concert with other measures (for example, T6 Transit Oriented Growth), the City has the opportunity to head down a more sustainable path. This standalone analysis focuses on the efficacy of GHG abatement potential relative to specific "green building" program components around the areas of energy consumption.

Arizona is a home rule State meaning that all building codes must be adopted at the local municipal level. Relative to energy codes, Tucson has adopted the 2006 International Energy Conservation Code, which is average, at best, relative to the rest of the nation. [3]

Description of Measure and Implementation Scenario:

Adopt the 2012 International Energy Conservation Code (IECC) for all new commercial and residential construction. Enforcement of the code commences January 1, 2013.

Business As Usual:

The energy code for all new construction in Tucson remains as 2006 IECC. The IECC has updated the 2006 code once in 2009. Tucson did not adopt that new code despite significant community-wide savings at minimal costs to the builder and homebuyer. The 2012 code is currently still being designed. However, robust literature exists enabling the quantification of additional costs and the resulting energy savings (see below).

Has the Measure been implemented elsewhere and with what results?:

Energy code adoption varies widely within the United States. For a complete listing of the adopted codes by jurisdiction, please see http://www.energycodes.gov/states/.

Energy/Emission analysis:

First, this analysis breaks down the individual components of the *Green Building Program* showing that, for the most part, the efficacy of these components is analyzed elsewhere in this report (the applicable Measure is highlighted) or considered outside the boundary of the regional GHG inventory. The major component of the Program that is not applicable to any other measure is exceeding the current local energy code (IECC 2006). Fortunately, great and local data exists to project energy and emission savings potentials if the IECC is updated to 2009 and to 2012. Given the energy savings outlined below, this analysis assumes an adoption of the 2012 (thus skipping the 2009 update) and commencing the enforcement January 1, 2013.

INDIVIDUAL COMPONENTS:

Resource Efficiency:
- Advanced Framing: this could result in a 20% reduction in lumber.[4] Collaboration with the residential build codes department would need to happen, but given that Tucson is not in a high wind or seismic zone, the results could result in approximately $1,000 savings per home. [5]
- HVAC that does not use refrigerants or non-HCFC refrigerants.
- Materials with recycled content.
- 18% fly-ash.
- Emission abatement potential for implementing these measures is considered to be outside the local GHG inventory.

Construction Waste Management: NA (see Measure G9- C&D Recycling).

Energy Efficiency:
- Passive Solar Design: Not analyzed.
- Energy Star Appliances: (see Measure E10 Promotion of Energy Efficiency through Construction Permitting).
- Energy Star Lighting Package: Covered by upgrading to the IECC 2012.
- Passive Solar Ventilation Pre-heater: Not analyzed.
- Install Solar Thermal Hot Water: (see Measure G2d Residential Thermal).
- Install Solar PV: (see Measure G2e Residential PV).
- Performance Path: Based on exceeding by 15% the current (2006) International Energy Conservation Code- please see the analysis below relative to upgrading to the 2012 IECC.

Beyond the above listed individual energy efficiency measures, the *Program* also includes picking one of two outlined paths for further energy efficiency points. These paths are:

Energy Program Path:
- WA would not suggest using the TEP Guarantee Home "Energy Program Path" as it mandates a guarantee home must have an electric water heater.[6] This is in direct

conflict with one of the most promising Measures considered in this report (see G2d Residential Thermal).

Prescriptive Path:
- ACCA Manual J: Already required in IRC 2006, which is the building energy code of Tucson.
- Energy Star rated windows: Covered by upgrading to the IECC 2012.
- Insulation Grade 1 and reducing air leakage (20% savings in heating cooling): Covered by upgrading to the IECC 2012.
- Energy Star Cool Roofing: (see Measure G8 Mandatory Cool Roof).

The above items are the individual components of the *City of Tucson Green Building Program*. Therefore, the major component worth evaluating is increasing the new building's energy performance over that of the currently adopted energy code. In the case of Tucson, this is the 2006 IECC. To this end, we evaluate the impact of upgrading to the 2012 IECC. The inputs, assumptions, and outputs for both residential and commercial construction are highlighted below.

Residential:
The per-home energy savings resulting from upgrading from IECC 2006 to 2012 for residential construction in the Phoenix area to be approximately 28%.[7] The average cost per square foot associated with adopting the 2009 IECC energy code over the 2006 IECC are approximated to be $0.34 / sqft for an energy savings of 17%.[8] Extrapolating that cost per square foot to the associated energy savings (ie, a linear relationship going from 17% to 28%) while assuming the average new home size at 1,800 sqft, the cost per home to upgrade from the 2006 to the 2012 IECC is approximately $1,000.

New home construction is assumed to average 3,500 homes per year at a 90% occupancy rate through 2020, which is consistent with all other measures in the report. The yearly energy usage of an average Tucson home is:
- Electricity: 11,000 kWh [9]
- Gas: 408 therms.[10]

Using the above inputs, the energy savings is calculated to be over 1.6 million tCO_2e over the life of the homes built with the newly adopted code (ie, through 2039). The abatement in 2020 totals over 82,000 tCO_2e.

Commercial:
Costs to upgrade commercial construction to the 2012 IECC is assumed to be 1.5 times the per square foot cost of residential as identified above. New commercial construction is assumed to average 1 million square feet per year through 2020, which is consistent with all other measures in the report. The average yearly commercial square foot energy is: [11]

- Electricity: 17 kWh/sqft/yr
- Gas: 0.329 therms/sqft/yr.

Using the above inputs, the energy savings is calculated to be over 730,000 tCO_2e over the life of the commercial space built with the newly adopted code (ie, through 2039). The abatement in 2020 totals over 36,000 tCO_2e.

Remodeling:
Due to the restrictiveness of the remodel guidelines and the lack of good data to support our calculations, remodeling was excluded from the analysis. The *Green Building Program* designates remodels to be over 500 square feet but within renovating 75% of the structure or replacement of all major systems.[12]

Contribution analysis:		
COT 1990 Citywide GHG emissions (baseline):[13]	5,461,020	tCO_2e
MCPA 7% reduction target for COT:	5,078,749	
2012 BAU GHG emissions projection:	7,000,000	
2020 BAU GHG emissions projection:	7,343,141	
GHG emissions reduction to meet 7% goal (2012):	1,921,251	
GHG emissions reduction to meet 7% goal (2020):	2,264,392	
Upgrading the Energy Code to 2012 IECC		
Contribution of G22 Expand Green Building Program / Energy Codes:	114,235	tCO_2e
2020 Contribution of G9 Mandatory C&D Recycling (assuming 80% mandate):	5.04	%

Economic analysis:

The cost analysis uses the calculated cost of $1,012 per home for residential construction, $0.843 per square foot for commercial construction, the energy forecast pricing outlined in the appendix of this report, and the above mentioned projected yearly construction.

The total costs to implement are as follows:
- Residential (2011-2020): $114.7 million
- Commercial (2011-2020): $30.4 million.

The total savings over the life of the program due to reduced energy usage:
- Residential (2011-2039): $279.1 million
- Commercial (2011-2039): $97.6 million.

The net savings over the life of the program (savings-costs):

- Residential (2011-2039): $164.4 million
- Commercial (2011-2039): $67.3 million.

The total net savings over the life of the program (residential + commercial) is $231.6 million.

The total tCO_2e abated over the life of the program is 2.376 million. The resulting net savings per tCO_2e abated is:

- ***Savings*** per tCO_2e = ***$ 97 / tCO_2e***

The cost to implement per tCO_2e is $61.

Co-benefits:

Some co-benefits associated with green building practices include: [14]

- Green buildings generate an average increase of 7.5 percent in a building's value and a 6.6 percent improvement in return on investment, while decreasing operating costs by 8 to 9 percent
- Higher revenue due to higher rents and occupancy rates. Vacancy rates of green buildings are lower than existing buildings
- Improved indoor air quality in green buildings result in reduced absenteeism, and possibly higher productivity.

Equitability:

There are no apparent equitability issues.

Potential unintended consequences:

None identified.

General Note: All references retrieved October through December of 2010 unless otherwise noted.

Endnotes:

[1] http://cms3.tucsonaz.gov/files/dsd/CityofTucsonGreenBuildingProgram.pdf
[2] Ibid.
[3] http://cms3.tucsonaz.gov/pdsd/codes-ordinances/building-codes
[4] http://cms3.tucsonaz.gov/files/dsd/CityofTucsonGreenBuildingProgram.pdf
[5] http://www.toolbase.org/PDF/DesignGuides/advancedwallframing1.pdf
[6] http://tucsonelectric.com/Green/GuaranteeHome/AboutGuarantee.asp
[7] http://www.energycodes.gov/publications/techassist/residential/Residential_Arizona.pdf
[8] http://www.greenbuildingadvisor.com/blogs/dept/green-building-news/average-cost-meeting-2009-iecc-not-much
[9] http://www.tucsonelectric.com/faqs/faqlist.php?faq=SolarPV
[10] Derived from SW Gas 2009 Annual Report for all their service areas. http://www.swgas.com/annualreport/swg_annual_report_2009.pdf assuming 90% of their customers are residences
[11] http://www.esource.com/BEA/demo/PDF/CEA_offices.pdf
[12] http://www.pimaxpress.com/Documents/Green/PC%20Regional%20Residential%20Green%20Remodeling%20Standard.pdf
[13] PAG Regional Greenhouse Gas Inventory- 2010
[14] http://www.greenbiz.com/business/research/tool/2009/09/16/benefits-green-building-and-retrofits